REMARKS

Claims 1-38 were presented for examination. Claims 1-38 were rejected. Claims 1, 5, 11-20, and 23 have been amended and claims 10 and 25-31 have been cancelled. New claim 39 has been added. Claims 11, 13, 15, 32, and 39 are independent.

Independent Claim 11

Independent claim 11, as amended, recites a device for generating hydrogen from a water vapor containing exhaust. The device comprising an exhaust diverter that is configured to divert a portion of said exhaust and deliver the diverted exhaust to a hydrogen generation section. The hydrogen generation section comprises an electrolysis unit. The electrolysis unit comprises an external box type manifold on an exhaust input side of the electrolysis unit. The width dimension of the electrolysis unit is defined along the external box type manifold and is at least twice as large as the length dimension of the electrolysis unit which is defined between the exhaust input side and an exhaust output side of the electrolysis unit. In addition, the hydrogen generation section is configured to deliver the hydrogen at a hydrogen output of the electrolysis unit.

Andrews discloses a self-replenishing liquid water source onboard an automobile for supplying liquid water to an electrolyzer. However, Andrews does not disclose an external box type manifold on the exhaust input of the electrolyzer. The presence of an external box type manifold increases the efficiency of the electrolysis operation. Further, Andrews also fails to disclose that the width of the electrolyzer is at least twice as large as the length of the electrolyzer as disclosed in the claimed invention. These dimensions optimize the hydrogen generation efficiency of the electrolyzer.

Zagaja discloses a system for generating hydrogen for use with an internal combustion engine. However, Zagaja also fails to disclose an external box type manifold on the exhaust input of the electrolyzer cell. Zagaja also fails to disclose that the width of the electrolyzer cell is at least twice as large as the length of the electrolyzer cell. Therefore, since neither reference

discloses these limitations, applicants respectfully assert that claim 11 is not anticipated by Andrews or Zagaja and request that the rejection be withdrawn.

Independent Claim 13

Independent claim 13, as amended, recites a device for generating hydrogen from a water vapor containing exhaust. The device comprises an exhaust diverter that is configured to divert a portion of said exhaust and deliver the diverted exhaust to a hydrogen generation section. The hydrogen generation section comprises an electrolysis unit. The electrolysis unit comprises an external box type manifold on an exhaust input side of the electrolysis unit. The external box type manifold is tapered from a maximum cross sectional area at an input side of the manifold to a minimum cross sectional area at an terminal end of the manifold. In addition, the hydrogen generation section is configured to deliver the hydrogen at a hydrogen output of the electrolysis unit.

Andrews fails to disclose an external box type manifold that is tapered from a maximum cross sectional area at an input side of the manifold to a minimum cross sectional area at an terminal end of the manifold as disclosed in the claimed invention to optimize flow field uniformity. Zagaja also fails to disclose a tapering external box type manifold. Therefore, since neither reference discloses this limitation, Applicants believe that claim 13 is not anticipated by Andrews or Zagaja and request the Examiner withdraw his rejection to claim 13.

Independent Claim 15

Independent claim 15, as amended, recites a device for generating hydrogen from a water vapor containing exhaust. The device comprising an exhaust diverter that is configured to divert a portion of said exhaust and deliver the diverted exhaust to a hydrogen generation section. The hydrogen generation section comprises an electrolysis unit. In addition, the hydrogen generation section is configured to deliver the hydrogen at a hydrogen output of the electrolysis unit and return the oxygen-enriched exhaust from the hydrogen generation section of the device to a non-diverted portion of the exhaust.

Andrews fails to disclose the return of an oxygen-enriched exhaust to a non-diverted portion of the exhaust. Instead, Andrews discloses returning the generated oxygen back to the water reservoir (Col. 8, lines 38-40; Col. 10 lines 14-15). Zagaja also fails to disclose returning the oxygen-enriched exhaust to a non-diverted portion of the exhaust after it exits the cell stack. Instead, Zagaja discloses releasing the oxygen directly to the atmosphere via a vent (Col. 4, lines 29-30; Col. 5, lines 45-46). Alternatively, Zagaja discloses returning the oxygen back to the internal combustion engine to assist in enhancing combustion (Col. 4, lines 30-32). Since neither embodiment discloses returning the diverted exhaust back to the non-diverted exhaust before the exhaust exits the device, Applicants believe that claim 15 is not anticipated by Andrews or Zagaja and request the Examiner withdraw his rejection to claim 15.

Independent Claim 32

Independent claim 32 recites a device comprising an engine configured to generate torque and a nitrogen oxide containing exhaust to at least one peripheral system, and a NO_X removal system for removing nitrogen oxides from the nitrogen oxide containing exhaust. The device comprises a NO_X removal system comprising a NO_X treatment section that is configured to remove nitrogen oxides from the exhaust. The device further comprises an exhaust diverter configured to divert a portion of the exhaust to a hydrogen generation section. The hydrogen generation section is configured to deliver hydrogen to the NO_X treatment section and to generate oxygen as a byproduct of hydrogen generation and deliver the oxygen with the diverted exhaust to a peripheral system.

Andrews fails to disclose delivering the generated byproduct oxygen with the diverted exhaust to a peripheral system. Instead, Andrews discloses returning the generated oxygen back to the water reservoir (Col. 8, lines 38-40; Col. 10 lines 14-15). In addition, Zagaja fails to disclose removing nitrogen oxides from said nitrogen oxide containing exhaust. Further, both Andrews and Zagaja fail to disclose a NO_X removal system for receiving hydrogen from a hydrogen generation section. In Andrews, the hydrogen is directed to the catalyst in a catalytic converter or vented to the atmosphere (Col. 10, lines 4-26). In Zagaja, the hydrogen is directed to

the internal combustion engine or released into the atmosphere (Col. 4, lines 54-58). Therefore, Applicants believe claim 32 is also not anticipated by Andrews or Zagaja, and request that the Examiner withdraw his rejection of claim 32.

Claims 2-9, 14, 16-24 and 33-38 depend on independent claims 11, 15 and 32 and are patentable for the same reasons as the independent claims from which they depend. Additionally, these dependent claims recite further limitations not shown or suggested by the prior art. For example, claim 12 recites flow field grooves extending as far as the external box type manifold. A limitation not disclose by either Andrews or Zagaja. Therefore, Applicants believe claims 2-9, 14, 16-24 and 33-38 are also not anticipated by Andrews or Zagaja and are also patentable over the prior art, and request that the Examiner withdraw his rejection of claims 2-9, 14, 16-24 and 33-38.

Independent Claim 39

Independent claim 39 expressly recites that the exhaust diverter is configured to direct "water vapor containing exhaust" to the hydrogen generation section. Further, the hydrogen generation section is recited to comprise an electrolysis unit configured to accumulate and store hydrogen generated by the electrolysis unit "directly from water vapor" in the water vapor containing exhaust. In contrast, the cited references teach systems where water vapor is first condensed to liquid water. The liquid water is then captured and fed to the electrolyzer. According to the present invention, as is recited in new claim 39, the condensation step is eliminated because moist gas is fed directly to the electrolyzer. State differently, the systems taught in the cited references electrolyze liquid water and produce a product containing a liquid water/oxygen 2-phase stream and a pure hydrogen product. The scheme recited in claim 39 relates to a system where moist engine exhaust is electrolyzed and used to produce an oxygen-enriched engine exhaust product and a pure hydrogen product.

The two types of schemes described above in relation to claim 39 differ significantly. For example, the Andrews patent will have a problem operating continuously at steady-state, as

once the engine warms up, it is likely to be quite difficult, if not impossible, to condense liquid water using engine coolant. The scheme described in the Andrews and Zagaja patents, where liquid water feeds the electrolyzer, necessitates that the gas must be cooled to below its dew point. In contrast, the scheme of the present invention enables continuous operation because there is no water reservoir to deal with. Further, the scheme of the present invention, where a water vapor containing exhaust is fed directly to the eletrolysis unit, permits the use of ambient air for cooling the diverted exhaust to above its dew point -a significantly easier proposition than the scheme taught in the cited references, as the ambient air is dozens of degrees cooler than engine coolant. Further, by directing water vapor directly to the electrolysis unit, the scheme of the present invention is not required to cool the diverted exhaust as far as is the case in the scheme of the cited references. Nor is there any need to get rid of the latent heat of condensation of the liquid water, as would be the case in the scheme of the cited references.

CONCLUSION

For the above reasons, the Applicants respectfully submit that the above claims represent allowable subject matter. The Examiner is encouraged to contact the undersigned to resolve efficiently any formal matters or to discuss any aspects of the application or of this response. Otherwise, early notification of allowable subject matter is respectfully solicited.

Respectfully submitted,
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